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# Activities of employers and OHS services during the developing COVID-19 epidemic in Poland

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## ABSTRACT

**Background:** The epidemic is affecting the global economy, plunging many industries. The global extent of the epidemic and government controls, restrictions and constraints have led to imbalances in world trade and have put many companies under pressure. The epidemic is a test of individual companies' ability to operate effectively in the new environment. It is up to managers to mitigate its impact on business. The aim of the article is to identify the activities of employers in Poland related to the protection of workers with the developing epidemic COVID-19.

**Methods:** A survey was carried out among the employees of OHS services employed in enterprises in Poland. The research was conducted in three stages at two-week intervals. The obtained results were subjected to statistical analyses.

**Results:** In the analysed three periods a total of 588 answers were obtained, which allowed to formulate conclusions. The research showed that in connection with the COVID-19 epidemic, about 30% of the plants updated their occupational risk assessment, about 40% updated their safety instructions, about 90% of the plants equipped their employees with additional personal protective equipment.

**Conclusions:** The COVID-19 outbreak in Poland resulted in taking additional actions by employers to protect workers. Systematicity (methodicality) of these activities depended mainly on the seniority of the OHS service. As a border internship indicating a different approach to an emergency situation related to the epidemic, 7 years were set.

## 1. Introduction

The epidemic started on 17 November 2019 in the city of Wuhan, Hubei Province in central China, and was declared a epidemic by the World Health Organisation (WHO) on 11 March 2020. Initially, the World Health Organization decided not to recognize the epidemic as a public health emergency of international scope. The WHO previously warned that further spread of the disease was possible. On 24 January 2020, the first case of infection in Europe was confirmed. The infection was diagnosed in two people: one in Paris and the other in Bordeaux. In the second half of February, larger outbreaks started to appear outside China. On 4 March 2020, the first case of coronavirus was reported in Poland.

The coronavirus epidemic has changed the way many companies work every day. A large part of companies started to work remotely, but not in all companies, e.g. production or health care, this mode of work is possible. Despite the progressive digitisation, robotisation and automation, there is no effectively functioning factory or company without

people. The physical work of people is necessary to maintain the continuity of the plant.

The health and safety service, in accordance with Polish legislation, is an advisory service for the employer, which is responsible for the safety situation in the establishment. The persons employed in the health and safety service must have secondary or higher education ([The Health and Safety Service Regulation, 1997](#)). Firms with more than 100 employees must separate the health and safety unit with at least one part-time employee and more than 600 employees with at least one part-time employee for every 600 employees. In smaller companies with up to 100 employees, the role of the health and safety service may be played by the employer, an employee with other work or a specialist from outside the company. Their knowledge and experience, especially in small and medium-sized enterprises, is the main factor determining the level of OSH in the company. Large enterprises, often operating within a corporation, have top-down procedures that greatly improve safety at work ([Chiroli et al., 2019](#); [Mansour, 2018](#); [Beardwood and Kainer, 2015](#)).

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Due to the increasing number of COVID-19 cases in Poland and Europe, employers are forced to take special measures to minimise the spread of the virus, ensure continuity of work and operation of the company and guarantee adequate protection for employees.

In normal working times, the OSH service relies on proven, repeatable, often informal procedures, resulting from existing legislation and principles based on good practice. In times of crisis, such as epidemics, the information available to health and safety professionals is incomplete and changes rapidly. Then health and safety workers must build on their experience and consultation opportunities.

Personal protective equipment (PPE) is used to protect workers from infection (Gralton and Mclaws, 2011; Tompkins and Kerchberger, 2010; Zhang et al., 2020). During an epidemic, PPE must be properly selected and used to minimise the risk of infection (Esswein et al., 2004; Moore et al., 2005; Nichol et al., 2008; Yassi et al., 2011; Wright et al., 2020a; Wright et al., 2020b). The selection concerns e.g. masks with the required characteristics, and the use of e.g. procedures to determine how protective clothing is to be worn, taken off and subsequently handled by healthcare personnel (Al-Tawfiq et al., 2018; MacIntyre et al., 2015). There is still a lack of experience in working in an epidemic situation among health and safety workers. There are many published studies that have focused on hygiene or SOI selection, but these most often concern hospitals (Ling and How, 2012; Martinese et al., 2009; Mitchell et al., 2013; Wright et al., 2020a; Al-Tawfiq et al., 2018; Wright et al., 2020b; Fix et al., 2019; Oh et al., 2017; Khalid et al., 2016). Based on the analysis of the literature, a research gap was identified in the field of operation of OSH services in unusual situations, which is an epidemic.

The aim of the article is to identify the activities of employers in Poland related to the protection of workers and to determine the relationship between the seniority of OSH services and these activities during the developing COVID-19 epidemic.

## 2. Material and methods

The hypothesis in the study was that: the way the health and safety service operates, especially in unusual situations, depends on the experience of its employees. There is a turning point in their seniority, above which they perform their tasks more methodically, based on their experience.

The research material consisted of the results of a questionnaire survey conducted among the employees of OHS services employed in enterprises in Poland. The research was conducted in three stages at two-weekly intervals, on days: 18–19 March 2020, 1–2 April 2020, 15–16.04.2020. Respondents at each stage provided answers to the questionnaire questions presented in Table 1: gender of respondents, their seniority in H&s service in years, industry (manufacturing industry, construction, health care, services, administration, trade - from

stage II, also other), size of the company (micro to 9 employees, small 10–49 employees, medium 50–249 employees, large more than 250 employees) - division by Law on Freedom of economic activity. Due to the limitations of direct communication, the survey was distributed on industry forums by means of social media and with the participation of the National Association of Health and Safety Service Employees.

Simultaneously with the surveys, current monitoring of the legal status and sanitary guidelines for employers in Poland and epidemiological monitoring in Poland and worldwide was conducted. Table 2 presents the number of confirmed infections and deaths in Poland and worldwide, in connection with COVID-19 during the successive stages of the research.

The results were analysed statistically, in the following ranges:

- scale reliability test -  $\alpha$ -Cronbach analysis (Cronbach, 1951) with Nunnally's criterion (Nunnally, 1976),
- normal distribution test - Lilliefors test (Lilliefors, 1967),
- comparative analysis of ordered categories - ANOVA Kruskal-Wallis test (Kruskal, 1952) and POST-HOC test with Dunn Bonferroni correction (Dunn, 1964) or Mann-Whitney *U* test (Mann and Whitney, 1947),
- a comparative analysis of unstructured categories - the Pearson chi-quadrat test (RxC) (Plackett, 1983),
- logistical modelling,
- Receiver Operating Characteristic ROC curve analysis (DeLong et al., 1988; Zweig and Campbell, 1993).

For each of the tests carried out, the confidence level  $\alpha < 0.05$  was assumed. The results were coded depending on the requirements of the method. The method of coding was presented each time the test results were presented. Analyses were conducted using Microsoft Excel 2019 and PQStat v 1.6.8.384.

## 3. Sanitary measures in enterprises in Poland in connection with the epidemic

In Poland, the first sanitary restrictions related to the threat of the COVID-19 virus epidemic became effective on 13 March 2020, when the Ordinance of the Minister of Health on declaring an epidemic hazard state in the Republic of Poland was issued. Restrictions on movement were introduced, including crossing the state border, and persons returning from abroad were obliged to undergo mandatory 14-day quarantine. This requirement did not apply to employees who cross the border of neighbouring countries as part of their professional activities. Restrictions also applied to the operation of workplaces. Temporary restrictions were established for e.g. catering entities, companies related to the organization of mass meetings, entrepreneurs dealing with

**Table 1**  
Research questionnaire (own elaboration).

No.	Question	Possible answers
1	In connection with COVID-19, I am updating the plant risk assessment	Yes, No
2	In connection with COVID-19, I am updating the work instructions for the positions	Yes, No
3	For COVID-19, I am equipping staff with additional Personal Protective Equipment	Yes, No
4	The information available on COVID-19 is enough for me, I know what to do	1; 2; 3; 4; 5 1 - means definitely No 5 - means definitely Yes
5	I consider the national measures taken to protect workers from COVID-19 to be sufficient	1; 2; 3; 4; 5 1 - means definitely No 5 - means definitely Yes
6	I consider the measures taken worldwide to protect employees from COVID-19 sufficient	1; 2; 3; 4; 5 1 - means definitely No 5 - means definitely Yes
7	During the ongoing epidemic, my employees feel safe in my facility	1; 2; 3; 4; 5 1 - means definitely No 5 - means definitely Yes

**Table 2**  
Epidemiological situation in the course of the study (own elaboration based on [www.esri.pl](http://www.esri.pl)).

Stage	Number of confirmed deaths in connection with COVID-19				Number of confirmed deaths in connection with COVID-19				Number of countries with COVID-19 confirmed	
	Start of research		End of research		Start of research		End of research		Start of research	End of research
	Poland	The world [thousands]	Poland	The world [thousands]	Poland	The world [thousands]	Poland	The world [thousands]		
I	238	198.2	355	244.5	5	8.0	5	10.0	155	160
II	2311	859.8	2946	1016.5	33	42.3	57	56.2	180	181
III	7202	1982.6	7918	2159.3	263	126.8	314	145.6	185	185

sports, culture or hospitality. A temporary ban on retail trade carried out on large sales areas was introduced (Ordinance of the Minister Health). The restriction concerning other industries was extended in the amendments to the Regulation. At the same time, the recommendations developed by the Chief Sanitary Inspector and the Ministry of Development were made available to employers. The recommendations included, first of all, the appeal for maintaining the safe distance from the interlocutor (1–1.5 m), promotion of regular and thorough hand washing with soapy water or disinfection with an alcohol-based agent (min. 60%), placing in visible places filled dispensers with the disinfectant, hanging instructions for effective hand washing. In addition, it is recommended that additional training be provided by and/or supervised by health and safety professionals (OHS service). Considerable attention has been paid to recommendations to reduce hand contact with the face area, especially lips, nose and eyes, to keep subordinates coughing and sneezing hygienically and to keep touch surfaces and common areas clean. The wearing of protective masks by healthy workers was not recommended. The managing authorities appealed to employers to enable their employees to work remotely wherever possible and the solution was particularly clearly recommended to employees returning from abroad. Also, guidelines were issued to limit business trips and foreign delegations, and according to the position of the National Labour Inspectorate, under the Labour Code, an employee had the right to refuse to participate in a foreign trip if a transmission of COVID-19 coronavirus in the country to which he was to go was to take place (Act – Labour Code, Law on Freedom...).

Due to the increase in the number of people infected with the virus, by introducing another regulation, the legislator announced the state of epidemics in Poland (Ordinance of the Minister Health). From March 25th to April 11th, the movement of people staying in Poland was banned, with a few exceptions, among others, performing professional activities. (Ordinance of the Minister Health). At the same time, the new ordinance of the Council of Ministers on establishing certain restrictions, orders and prohibitions in connection with the outbreak of the state of the epidemic, introduced further restrictions for entrepreneurs, preventing them from running companies related to, among others, the cosmetics or sports industry. A ban was also introduced on retail trade in construction and renovation articles, carried out on large areas on Saturdays and Sundays. Further restrictions concerned restrictions on the number of people staying in commercial facilities – 3 people per one cash desk. Shops were obliged to provide customers with disposable gloves or hand disinfectants, and employees of commercial facilities were required to disinfect service stations. The legislator, in the regulation [Ordinance of the Minister Health], referred to employers who were ordered to provide disposable gloves or hand disinfectants to employees, regardless of the basis of employment. The legal act specified the distance between workstations, which should be at least 1.5 m. The amendment of the regulation, gave employers the possibility to deviate from the required distance between workstations only due to the nature of the work performed. In such a case, it was recommended that the workplace should provide personal protective equipment dedicated to fighting the COVID-19 epidemic (Ordinance of

the Minister Health). By the amending regulation, on 16 April 2020, the legislator imposed the obligation to cover the mouth and nose with clothes or parts thereof, a mask or a mask. This obligation should be performed in generally accessible places, including workplaces. However, it has been clarified that the restriction applies to employees providing direct service to stakeholders or customers. The employees were given the opportunity to cover their mouths and nose with a visor, which had been used in many places already before, provided that the place of service was separated from the customers with an additional protective screen (Ordinance of the Minister Health). Moreover, the recommendations of sanitary services concerned the necessity to instruct employees on the proper use of gloves and protective masks.

During the state of the epidemic, employers could count on various forms of support in conducting business activity, also in the area of work safety. e.g. there was a temporary possibility to carry out initial training by means of electronic communication - except for job instructions at worker's positions or positions where dangerous factors occur. The on special support instruments in connection with the spread of the COVID-19 virus regulates the validity of periodic occupational health and safety training, extending its validity to 60 days after the cancellation of the emergency (Act on specific support...). Ad hoc changes were also introduced in occupational medicine. The performance of periodic tests has been suspended and the validity of studies that are being completed has been extended by 60 days after the end of the epidemic. The preliminary or control examinations must be carried out but may be performed by a physician not authorised for this type of examination and the amendment of the regulation indicated that such a medical certificate expires 30 days after the end of the epidemic. Additionally, all examinations and certifications could be carried out remotely (Ordinance of the Minister Health).

The Ministry of Development has made guidelines for industrial plants during the COVID-19 epidemic available on its official website. The procedures developed aim to ensure the safety of industrial plant workers, to avoid the infection of workers with the virus by people from outside the organisation (suppliers, customers), to reduce the number of people-to-people contacts within the plant and to maintain the possibility for these companies to provide work. The Ministry's recommendations concerned, among other things, the implementation of contact-free temperature measurement in companies for employees and visitors before entering the premises. The recommendations specified in more detail the obligation to ensure the protection of workers' faces and hands, and the protective measures included safety glasses, distance barriers, visors, goggles, masks and any other tools ensuring isolation. At the same time, companies were recommended to purchase reusable masks with industrial standard of protection. Another indication was to limit the use of common spaces, including changing the hours of breaks in work, reducing the number of places in company canteens or verifying the necessity to use changing rooms and baths on the premises. The recommendations concern, among others, changes in the system of work and hours, creation of small working teams, introduction of remote work, suspension of delegations, trade meetings, conducting employee briefings in open areas, and meetings and deliberations at open

**Table 3**

Sanitary guidelines applicable to employers in Poland during the COVID-19 epidemic (Own study based on: Regulations of the Council of Ministers on establishing certain restrictions, orders and prohibitions in connection with the occurrence of a state of epidemic).

Stage I of research Until 19 March 2020	<ul style="list-style-type: none"> <li>• extending the period of validity of periodic health and safety training (to 60 days after the epidemic)</li> <li>• the possibility of providing initial training in the field of health and safety through electronic means of communication (except for)</li> <li>• the possibility of performing the work specified in the contract of employment, outside the place of its permanent performance (remote work)</li> <li>• Temporary limitation of conducting business activity by entrepreneurs in specific industries</li> <li>• temporary limitation of retail activity on sales areas above 2000 m<sup>2</sup> - selected industries</li> <li>• the possibility of conducting initial and follow-up examinations by a doctor not authorised to perform occupational medicine examinations - validity of the certificate 30 days after the end of the epidemic</li> <li>• possibility of changing the system or working time schedules</li> <li>• the possibility of ordering employees to work overtime to the extent necessary for the operation of the company</li> <li>• the possibility of obliging the employee to remain outside normal working hours on standby to perform work in the company</li> </ul>
Stage II research until 2 April 2020	<ul style="list-style-type: none"> <li>• prohibition of movement/exception of professional activities</li> <li>• the obligation to provide employees with disposable gloves or hand disinfectants</li> <li>• an obligation to maintain a distance between workplaces of at least 1.5 m + if not possible, personal protective equipment</li> <li>• limitation of the number of customers at checkout desks (to 3) + obligation for customers to use disposable gloves</li> <li>• obligation to disinfect service stations</li> <li>• Temporary limitation of conducting business activity by entrepreneurs in specific sectors (additional sectors)</li> <li>• temporary limitation of commercial activity on sales areas above 2000 m<sup>2</sup> - additional sectors</li> <li>• the obligation to cover the nose and mouth with clothing or parts of clothing, a mask or a mask at the workplace (with exceptions) - from 16 April</li> </ul>
Stage III research until 16 April 2020	

doors and windows.

Health and safety training, which is one of the basic responsibilities of any employer, including during a virus epidemic, must be provided. The employer is obliged to provide the necessary knowledge about protection against risks. The recommendations of the Chief Sanitary Inspector, the National Labour Inspectorate and the Ministry of Development indicate that entrepreneurs, taking into account the health of employees, should limit training in the traditional form. During the ongoing epidemic, it was proposed to instruct subordinates through online training, self-education in the form of e-learning, e-mail or posting the necessary information in publicly accessible places on the premises.

An important part of the fight against the spread of the COVID-19 virus in all workplaces was to carry out preventive decontamination procedures in places such as entrances, main passages, changing rooms, handles, handrails, desks and desks. This recommendation is maintained continuously by all health surveillance services.

Many of the actions outlined above were only legally binding recommendations. The guidelines valid during the various stages of the study are summarized in Table 3.

#### 4. Results

In the analysed periods the following number of completed questionnaires was obtained:

- Stage I – 311,
- Stage II – 146,
- Stage III – 131.

The seniority of the respondents ranged from 0 (to 1 year) to 35 years. The work seniority of the respondents was tested by means of the Lilliefors test, obtaining a  $p < 0.000001$  value for each of the stages. In order to determine the possible influence of the respondents' experience on their answers, the ANOVA Kruskal-Wallis test was conducted. As a result of the test, the statistics  $H = 1.426$  and  $p = 0.490$  were determined. On this basis,  $H_0$  was assumed, concluding that there were no statistically significant differences between the work experience of the respondents in the OHS service at each stage of the study. The distribution of work experience of respondents is shown in Fig. 1.

Questions 4–7 were answered on the Likert scale from 1 to 5, where 1 meant “definitely no” and 5 meant “definitely yes”. In order to determine the reliability of the tool, the  $\alpha$ -Cronbach compliance rate was determined for each stage. The results of the analysis are presented in

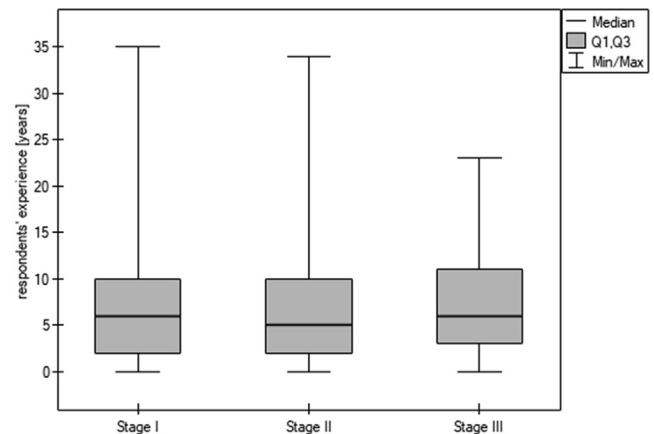


Fig. 1. Seniority distribution of respondents in the OHS service (own elaboration).

Table 4. Using the Nunall's criterion, indicating the desired value of 0.7 of the  $\alpha$  coefficient, confirming the reliability of the test tool, and taking into account that the value of the  $\alpha$ -Cronbach compliance coefficient above 0.65 is also acceptable, satisfactory reliability of the tool was assumed.

The results of the tests for questions 1–3 on updating the risk assessment, safety instructions and equipping workers with additional personal protective equipment are presented in Table 5. The results of the tests were subjected to a chi-quadrat test (RxC) with the following results:

- question 1 - chi-quadrat 4.118,  $p = 0.128$ ;
- question 2 - chi-quadrat statistics 1.774,  $p = 0.418$ ;
- question 3 - chi-quadratic 24.503,  $p = 0.000005$ .

Based on statistics  $p$ , a statistically significant difference was found between the results of question 3 on equipping employees with additional personal protective equipment in individual stages of the study. In questions 1 and 2 no such differences were found in the middle values.

Answers to questions 1–3, taking into account the criterion of the length of service, company size and industry, are presented in Tables 6–8. The length of service, due to the wide range and fragmentation of results, is compared in classes. For each of the adopted criteria, a comparative analysis was carried out in all stages using a chi-quadrat



**Table 4**  
Reliability analysis of the scale for questions 4–7 (own elaboration).

Stage	Average scale	Standard deviation of the scale	Average pair correlations	$\alpha$ -Cronbach standardized
I	12.655	3.131	0.332	0.665
II	13.370	2.665	0.266	0.692
III	13.901	2.768	0.269	0.700

**Table 5**  
Results of surveys concerning updates of the Occupational Risk Assessment, health and safety instructions and equipping workers with additional personal protective equipment (own elaboration).

Stage	Question 1 Risk assessment	Question 2 Instructions	Question 3 Personal protective equipment
I	Yes 34.4% No 65.6%	Yes 38.3% No 61.7%	Yes 76.5% No 23.5%
II	Yes 25.3% No 74.7%	Yes 39.7% No 60.3%	Yes 89.0% No 11.0%
III	Yes 34.4% No 65.6%	Yes 45.0% No 56.0%	Yes 93.9% No 6.1%

test. On the basis of the determined p-statistics, statistically significant differences were found only in the results of the stage I research, concerning the following:

- the size of the enterprise and the update of the health and safety instructions ( $p = 0.026$ ),
- the seniority of the respondents in the health and safety service ( $p = 0.013$ ),
- seniority in the health and safety service of respondents and updates to health and safety instructions ( $p = 0.047$ ).

The comparative analysis was continued for the obtained results of each group, determining the percentage of responses and assuming the H0 or H1 hypothesis depending on statistics p presented in Tables 6–8.

The results of the tests using the Likert scale - questions 4–7 were compiled by determining for each case descriptive statistics - Table 9, and determining the distribution of data using the Lilliefors test. For each of the analyzed questions, the distribution was different from normal ( $p < \alpha$ ). The differences in middle values were compared with the Kruskal-Wallis test, followed by POST-HOC. The results are presented in Table 10.

The results of questions 4–7 were coded, taking 3 as neutral, 1 and 2 as negative, 4 and 5 as positive. Obtained answers were juxtaposed by determining the percentages for each group. In order to determine the significance of differences between the results, they were subjected to the chi-square (RxC) test. The results obtained are presented in Table 11. The identified differences in the assessments are graphically presented in Figs. 2–5.

In order to confirm the assumed hypothesis for stage I results, a multi-factor logistic model was built taking into account all adopted criteria in the study. An update of the occupational risk assessment was assumed to be the highlighted value. The result of the reliability quotient test was  $p = 0.0057$ , which is less than the assumed confidence level. Out of all analyzed variables only  $p < \alpha$  ( $p = 0.0002$ ) was found in the case of seniority. For the remaining variables  $p > \alpha$ . This result confirms the assumption about the influence of the length of service in OSH on the decision to update the occupational risk assessment. Similar results were obtained for the logistic model, where the value of the update of the safety instructions was highlighted. For the reliability quotient test  $p = 0.007$  was obtained and for the work experience of the respondents  $p = 0.002$ . The influence of individual variables in the case of occupational risk assessment is presented in Fig. 6 and in the case of safety instructions in Fig. 7.

In order to confirm the assumed hypothesis, for the data obtained in

**Table 6**  
Results of studies on updating the occupational risk assessment during the epidemic in Poland (own elaboration).

	Stage I	Stage II	Stage III
Criterion - size of company			
Micro	Yes 54.6% No 45.4%	Yes 37.5% No 62.5%	Yes 0% No 100%
( $p = 0.159$ )			
Small	Yes 40.7% No 59.3%	Yes 21.1% No 78.9%	Yes 46.7% No 53.3%
( $p = 0.241$ )			
Medium	Yes 25.5% No 74.5%	Yes 25.0% No 75.0%	Yes 43.2% No 56.8%
( $p = 0.102$ )			
Big	Yes 37.1% No 62.9%	Yes 25.3% No 74.7%	Yes 29.3% No 70.7%
( $p = 0.149$ )			
Criterion - industry			
Services	Yes 40% No 60%	Yes 25.0% No 75.0%	Yes 54.6% No 45.4%
( $p = 0.293$ )			
Healthcare	Yes 43.8% No 56.2%	Yes 25% No 75%	Yes 50% No 50%
( $p = 0.461$ )			
Production	Yes 29.6% No 70.4%	Yes 26.4% No 73.6%	Yes 34.0% No 66.0%
( $p = 0.706$ )			
Construction	Yes 40.0% No 60.0%	Yes 25.0% No 75.0%	Yes 43.8% No 56.2%
( $p = 0.430$ )			
Administration	Yes 40.9% No 59.1%	Yes 8.3% No 91.7%	Yes 40.0% No 60.0%
( $p = 118$ )			
Trade	Lack of data	Yes 33.3% No 66.7%	Yes 0% No 100%
( $p = 114$ )			
Other	Yes 32.4% No 67.6%	Yes 29.2% No 70.8%	Yes 21.4% No 78.6%
( $p = 564$ )			
Criterion - gender of respondents			
Female	Yes 35.4% No 64.6%	Yes 24.7% No 75.3%	Yes 36.5% No 63.5%
( $p = 0.169$ )			
Male	Yes 32.8% No 67.2%	Yes 26.2% No 73.8%	Yes 31.6% No 68.4%
( $p = 0.660$ )			
Criterion - seniority of respondents in the OHS service [years]			
to 1	Yes 12.5% No 87.5%	Yes 100% No 0%	Yes 42.9% No 57.1%
( $p = 0.008$ )			
above 1 to 2	Yes 22.6% No 77.4%	Yes 27.3% No 72.7%	Yes 41.7% No 58.3%
( $p = 0.444$ )			
over 2 to 5	Yes 28.6% No 71.4%	Yes 20.4% No 79.6%	Yes 22.7% No 77.3%
( $p = 0.508$ )			
over 5 to 10	Yes 38.6% No 61.4%	Yes 22.9% No 77.1%	Yes 42.4% No 57.6%
( $p = 0.178$ )			
over 10 to 15	Yes 42.6% No 57.4%	Yes 28.0% No 72.0%	Yes 29.2% No 70.8%
( $p = 0.357$ )			
over 15	Yes 55.2% No 44.8%	Yes 37.5% No 62.5%	Yes 54.6% No 45.4%
( $p = 0.664$ )			

**Table 7**

Results of studies on updating health and safety instructions during the epidemic in Poland [own elaboration].

	Stage I	Stage II	Stage III
Criterion - size of company			
Micro	Yes 54.6%	Yes 37.5%	Yes 50.0%
	No 45.4%	No 62.5%	No 50.0%
(p = 0.760)			
Small	Yes 48.2%	Yes 31.6%	Yes 60.0%
	No 51.8%	No 68.4%	No 40.0%
(p = 0.2440)			
Medium	Yes 26.5%	Yes 36.4%	Yes 46.0%
	No 73.5%	No 63.6%	No 54.0%
(p = 0.087)			
Big	Yes 42.3%	Yes 44.0%	Yes 41.3%
	No 57.7%	No 56.0%	No 58.7%
(p = 0.945)			
Criterion - industry			
Services	Yes 51.1%	Yes 50.0%	Yes 45.4%
	No 48.9%	No 50.0%	No 54.6%
(p = 0.945)			
Healthcare	Yes 50.0%	Yes 50.0%	Yes 87.5%
	No 50.0%	No 50.0%	No 12.5%
(p = 0.165)			
Production	Yes 32.8%	Yes 24.5%	Yes 34.0%
	No 67.2%	No 75.5%	No 66.0%
(p = 0.490)			
Construction	Yes 42.9%	Yes 60.0%	Yes 56.3%
	No 57.1%	No 40.0%	No 43.7%
(p = 0.417)			
Administration	Yes 36.4%	Yes 58.3%	Yes 53.3%
	No 63.6%	No 41.7%	No 46.7%
(p = 0.395)			
Trade	Lack of data	Yes 33.3%	Yes 50.0%
		No 66.7%	No 50.0%
(p = 0.519)			
Other	Yes 35.3%	Yes 37.5%	Yes 39.3%
	No 64.7%	No 62.5%	No 60.7%
(p = 0.930)			
Criterion - gender of respondents			
Female	Yes 38.0%	Yes 41.2%	Yes 46.0%
	No 62.0%	No 58.8%	No 54.0%
(p = 0.492)			
Male	Yes 38.7%	Yes 37.7%	Yes 43.9%
	No 61.3%	No 62.3%	No 56.1%
(p = 0.753)			
Criterion - seniority of respondents in the OHS service [years]			
up to 1	Yes 25.0%	Yes 100%	Yes 57.1%
	No 75.0%	No 0%	No 42.9%
(p = 0.035)			
above 1 to 2	Yes 32.3%	Yes 45.5%	Yes 50.0%
	No 67.7%	No 54.5%	No 50.0%
(p = 0.514)			
over 2 to 5	Yes 37.1%	Yes 35.2%	Yes 47.7%
	No 62.9%	No 64.8%	No 52.3%
(p = 0.388)			
over 5 to 10	Yes 34.9%	Yes 40.0%	Yes 42.4%
	No 65.1%	No 60.0%	No 57.6%
(p = 0.719)			
over 10 to 15	Yes 38.3%	Yes 36.0%	Yes 25.0%
	No 61.7%	No 64.0%	No 75.0%
(p = 0.526)			
over 15	Yes 65.5%	Yes 50.0%	Yes 72.7%
	No 34.5%	No 50.0%	No 27.3%
(p = 0.585)			

stage I of the study, a diagnostic test of the ROC curve was carried out, assuming as a diagnostic variable length of service and a status variable an update of the risk assessment. A statistically significant model ( $p = 0.0002$ ) was built, determining the cut-off point of employees' seniority as 7 years. Diagnostic chart of sensitivity/specificity is shown in Fig. 8. Analogous results were obtained by assuming the safety manual update as a status variable ( $p = 0.002$ ), determining the cut-off point also as 7 years (Fig. 9). Based on the above results, it was found that for the group of OHS service workers in question, experience calculated in terms of work experience results in the change of undertaken actions into methodical ones at the expense of reactive ones after

**Table 8**

Results of research on equipping workers with additional Personal Protection Equipment during the epidemic in Poland (own elaboration).

	Stage I	Stage II	Stage III
Criterion - size of company			
Micro	Yes 63.6%	Yes 87.5%	Yes 100%
	No 36.4%	No 12.5%	No 0%
(p = 0.235)			
Small	Yes 74.1%	Yes 79.0%	Yes 93.3%
	No 25.9%	No 21.0%	No 6.7%
(p = 0.317)			
Medium	Yes 73.5%	Yes 90.9%	Yes 91.9%
	No 26.5%	No 9.1%	No 8.1%
(p = 0.009)			
Big	Yes 79.4%	Yes 90.7%	Yes 94.7%
	No 20.6%	No 9.3%	No 5.3%
(p = 0.003)			
Criterion - industry			
Services	Yes 82.2%	Yes 93.8%	Yes 100%
	No 17.8%	No 6.2%	No 0%
(p = 0.193)			
Healthcare	Yes 68.8%	Yes 100%	Yes 100%
	No 31.2%	No 0%	No 0%
(p = 0.027)			
Production	Yes 78.4%	Yes 94.3%	Yes 95.7%
	No 21.6%	No 5.4%	No 4.3%
(p = 0.002)			
Construction	Yes 80.0%	Yes 85.0%	Yes 93.8%
	No 20.0%	No 15.0%	No 6.2%
(p = 0.451)			
Administration	Yes 86.4%	Yes 91.7%	Yes 86.7%
	No 13.6%	No 8.3%	No 13.3%
(p = 0.893)			
Trade	No data	Yes 77.8%	Yes 83.3%
		No 22.2%	No 16.7%
(p = 0.792)			
Other	Yes 66.2%	Yes 75.0%	Yes 92.9%
	No 33.8%	No 25.0%	No 7.1%
(p = 0.025)			
Criterion - gender of respondents			
Female	Yes 77.6%	Yes 87.1%	Yes 97.3%
	No 22.4%	No 12.9%	No 2.7%
(p = 0.0003)			
Male	Yes 74.8%	Yes 91.8%	Yes 89.5%
	No 25.2%	No 8.2%	No 10.5%
(p = 0.005)			
Criterion - seniority of respondents in the OHS service [years]			
up to 1	Yes 75.0%	Yes 100%	Yes 85.7%
	No 25.0%	No 0%	No 14.3%
(p = 0.558)			
above 1 to 2	Yes 74.2%	Yes 90.9%	Yes 9.7%
	No 25.8%	No 9.1%	No 8.3%
(p = 0.207)			
over 2 to 5	Yes 75.2%	Yes 90.7%	Yes 97.7%
	No 24.8%	No 9.3%	No 2.3%
(p = 0.0008)			
over 5 to 10	Yes 75.9%	Yes 88.6%	Yes 97.0%
	No 21.4%	No 11.4%	No 3.0%
(p = 0.015)			
over 10 to 15	Yes 80.9%	Yes 88.0%	Yes 87.5%
	No 19.1%	No 12.0%	No 12.5%
(p = 0.647)			
over 15	Yes 79.3%	Yes 75.0%	Yes 90.9%
	No 20.7%	No 25.0%	No 9.1%
(p = 0.622)			

obtaining 7 years of experience.

During the course of the study, the retrofitting of workers with protective measures was observed, especially in two sectors: health care and manufacturing industry. Graphical results are presented in Figs. 10 and 11.

By coding the responses as positive, neutral and negative, the positive assessment of employer performance increases from 36.7% in Stage I to 70.2% after one month in Stage III. Graphically, these results are shown in Fig. 12.

**Table 9**  
Descriptive statistics of test results - questions 4–7 (own elaboration).

Question No.	Stage	Arithmetic mean	Coefficient of variation	Mediana	Trend
4	I	3.794	0.291	4	5
	II	4.123	0.213	4	5
	III	3.962	0.233	4	4
5	I	3.154	0.381	3	multiple
	II	3.151	0.370	3	3
	III	3.183	0.341	3	3
6	I	2.617	0.403	3	3
	II	2.678	0.351	3	3
	III	3.001	0.304	3	3
7	I	3.090	0.344	3	3
	II	3.418	0.277	3	3
	III	3.748	0.230	4	4

**Table 10**  
Results of the Kruskal-Wallis test - questions 4–7 (own elaboration).

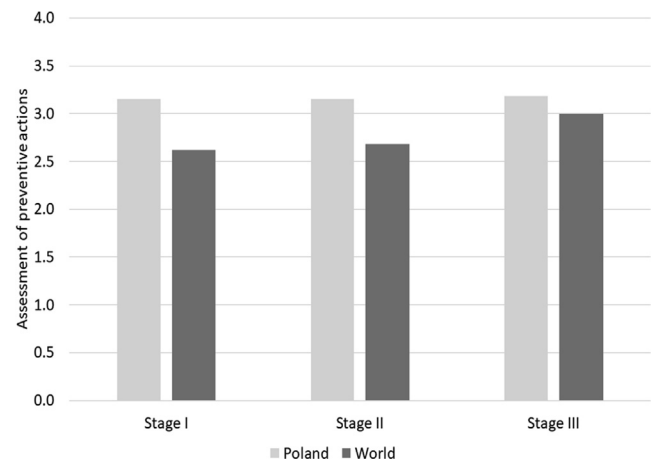
Question No.	statistic H	p-value	POST-HOC test			
4	7.951	0.019	etap	I	II	III
			I		0.015	0.749
			II	0.015		0.540
5	0.019	0.991	etap	I	II	III
			I		1	1
			II	1		1
6	17.403	0.0002	etap	I	II	III
			I		0.919	0.00009
			II	0.919		0.018
7	41.373	< 0.0001	etap	I	II	III
			I		0.013	< 0.0001
			II	0.013		0.005

**Table 11**  
Survey results (questions 4–7) for answers to questions 4–7 (own elaboration).

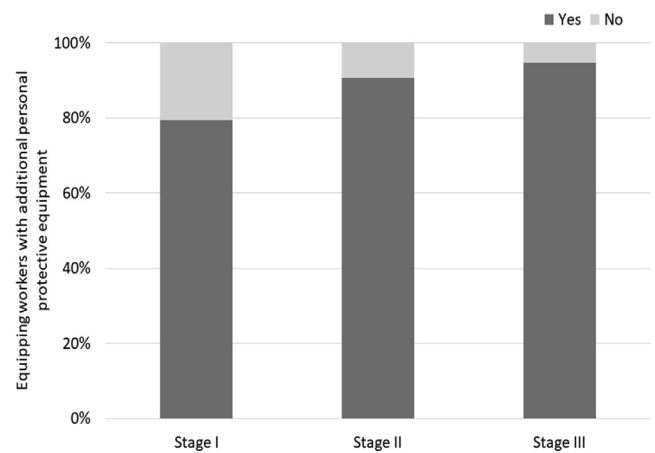
Question No.	Chi-quadrat statistics	p-value	Stage	Evaluation		
				Positive	Neutral	Negative
4	12.380	0.015	I	6.4%	25.7%	11.9%
			II	74.0%	22.6%	3.4%
			III	73.5%	19.1%	8.4%
5	4.942	0.293	I	42.1%	28.3%	29.6%
			II	37.7%	37.0%	25.3%
			III	38.2%	36.6%	24.2%
6	20.777	0.0003	I	16.4%	37.9%	45.7%
			II	15.7%	47.3%	37.0%
			III	28.2%	46.6%	25.2%
7	44.837	< 0.0001	I	36.7%	37.9%	25.4%
			II	47.3%	37.0%	15.7%
			III	70.2%	20.6%	9.2%

## 5. Discussion

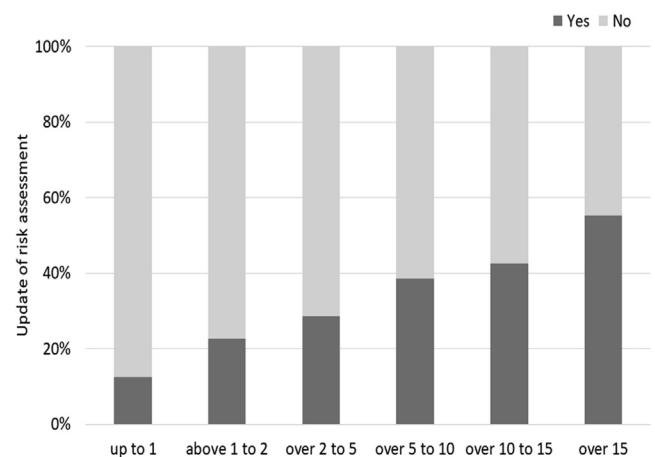
Respondents' answer to the question about the availability and legibility of information that results in the knowledge about the actions to be taken in relation to the coronavirus COVID-19 epidemic showed a relatively good level of knowledge, increasing in function of time. In the first stage of the study the average response was 3.79 with almost 12% of negative responses. The first stage of the study was conducted 14 days after official confirmation of the first coronavirus infection in



**Fig. 2.** Assessment of preventive actions taken in Poland and worldwide (own elaboration).



**Fig. 3.** Equipping workers with additional personal protective equipment in connection with COVID-19 (own elaboration).



**Fig. 4.** Update of the COVID-19 risk assessment according to the seniority of the OSH service in Phase I of the study (own elaboration).

Poland. By that time, schools and universities were closed down by the government's decision, introducing social restrictions in the form of, for example, closing the borders and mandatory quarantine at the beginning of the fight against the epidemic in Poland. At the same time, guidelines appeared, although not always through official government channels, what actions should be taken by employers to limit further infections. This resulted in an increase in the knowledge of the health



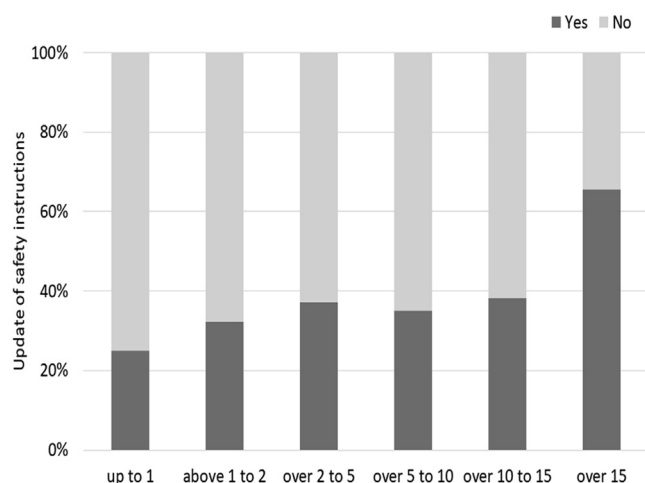


Fig. 5. Update of safety instructions in connection with COVID-19 depending on the seniority of the health and safety service in the first stage of tests (own elaboration).

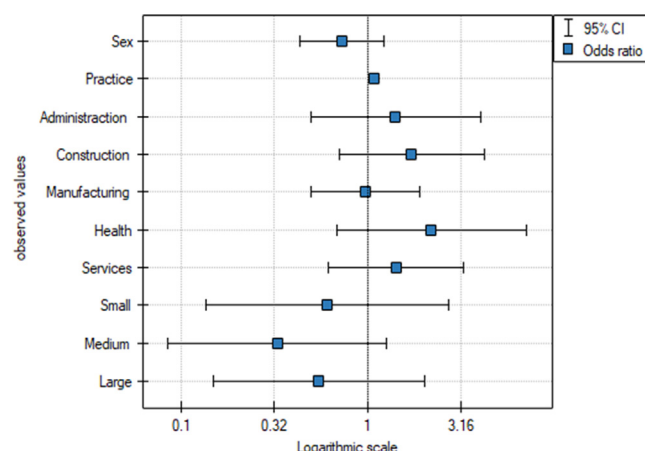


Fig. 6. Influence of the analysed variables on the update of occupational risk assessment during a epidemic (own elaboration).

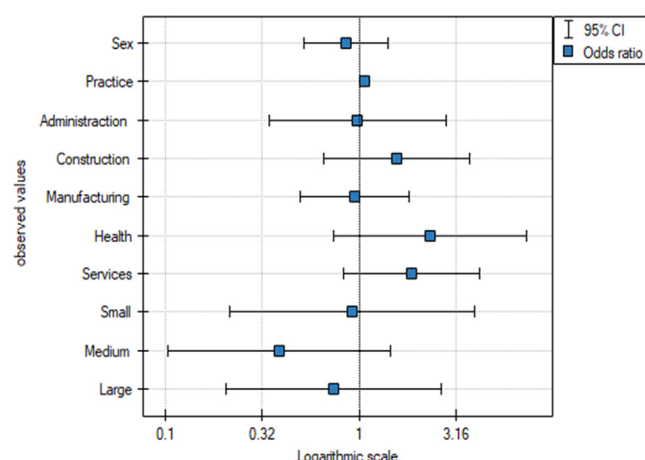


Fig. 7. Influence of the analysed variables on the update of safety instructions during an epidemic (own elaboration).

and safety service, which was observed in the next, second stage of research (average 4.12 and 3.4% of negative opinions).

Masmedia provided daily broad information on the activities of individual countries during the developing epidemic, which differed significantly in Europe depending on the epidemiological situation.

These actions of some countries introduced a strict sanitary regime already at the beginning of the epidemic (e.g. in Poland), while in others those in power planned to acquire so-called social (national) immunity without introducing strict sanitary restrictions in the first stage of the fight (e.g. Great Britain). As a group particularly interested in the issues of protecting citizens, the health and safety workers, assessing from the perspective of Poland the actions taken in the country and information about the actions and their effects, expressed in the number of infections and deaths due to COVID-19 in the world, evaluated the national actions much better. The differences between the evaluations decreased only in stage III of the study, when a sharp increase in coronavirus-related deaths was already recorded in Italy, Spain, France and the USA [<https://www.gov.pl/web/rozwoj>], and the actions of all countries resulted in a significant extinction of the economy and social isolation of citizens, as shown in Fig. Such an assessment is confirmed by the results of Mann-Whitney's *U* test, indicating the statistical significance of the differences in assessments during stage I ( $p < 0.00001$ ) and II ( $p = 0.0002$ ), and the lack of statistical significance in stage III ( $p = 0.175$ ). In Poland at that time the incidence and mortality curve was significantly lower than in many countries, although the mode of testing and registering deaths aroused much controversy, mainly due to the relatively low number of tests performed [<https://www.pip.gov.pl/>].

The change in the assessment of global activities is confirmed by the POST-HOC test result, which showed a statistically significant difference in the results of the answer to question 6 on global activities undertaken in stage III ( $p = 0.00009$  and  $p = 0.018$ ) (see Fig. 13).

The basis of the activity of the OHS service is the current monitoring of the work environment and reacting to its variability. In formal terms, this manifests itself in two ways: documentation in the form of updating the occupational risk assessment and safety instructions (procedures) and practically in the form of selecting and equipping employees with additional protective measures. In the opinions expressed in the course of the research, the health and safety workers were represented by two groups, whose actions determined the statements: "we're here to act rather than create documentation" and "the choice of protective measures must be preceded by a thorough analysis". The research showed that during the epidemic, 25–35% of companies carried out an update of their occupational risk assessment. This update was carried out mainly at the beginning of the epidemic. No statistically significant differences in the results of the individual stages were noted. The situation was similar in the case of the update of safety instructions, although in this case the percentage of establishments where this process was carried out was higher, amounting to approx. 38–45%.

The situation was different for personal protective equipment. In the first stage of the research, such activities were declared by 76.5% of the respondents, and in the subsequent ones by 89.0% and 93.9% respectively. The results of the chi-squared statistics confirm the significance of differences in the results obtained in particular stages of the research ( $p = 0.000005$ ). A detailed analysis of actions taken during the epidemic showed a statistically significant impact of the seniority of the OSH service, i.e. its experience on the update of occupational risk assessment and OSH instructions in stage I. It was found that the increase in the percentage of OSH workers updating their risk assessment and instructions is directly proportional to their length of service. Experienced workers with less than a year's experience in OSH have only updated their risk assessment in 12.5% of cases and safety instructions in 25% of cases, while their older colleagues with more than 15 years' experience have updated their risk assessment in 55.2% and instructions in 65.5% of cases. These results indicate a more structured, systematic way of working in OSH as staff experience increases. This conclusion is confirmed by the observations of the specialist forums at a time of dynamic change. This correlation was not found in the case of personal protective equipment or follow-up studies.

Further analysis of the research results indicates two sectors in which the policy of equipping employees with personal protective

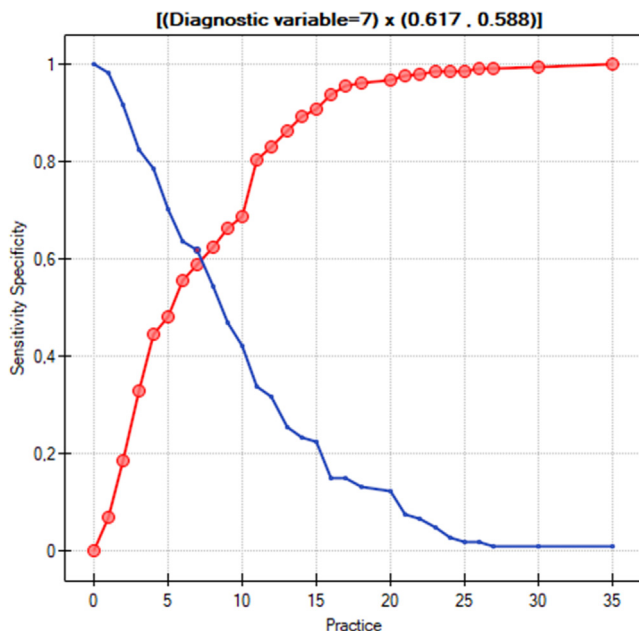


Fig. 8. ROC curve for the relation between seniority of OSH service and update of occupational risk assessment (stage I of the study) (own elaboration).

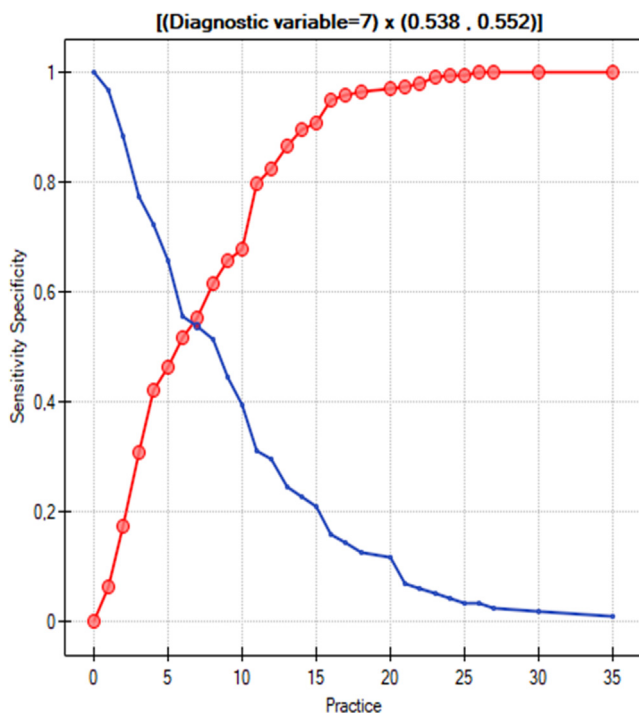


Fig. 9. ROC curve for the relationship between the work experience of the OHS service and the update of safety instructions (stage I tests) (own elaboration).

equipment has changed between the different stages. These sectors are health care and manufacturing industries. In both cases, statistically significant differences were observed between the results obtained in the subsequent stages, indicating an increase in the percentage of equipped workers between the first and second stage of the research. In the case of health care workers, it was 100% of the establishments in which employees were equipped with additional personal protective equipment. Such measures, although positive, should be assessed negatively, as they indicate insufficient preparation of health care facilities for a possible epidemic that officially occurred at least two months earlier in China and a few weeks earlier in other European countries.

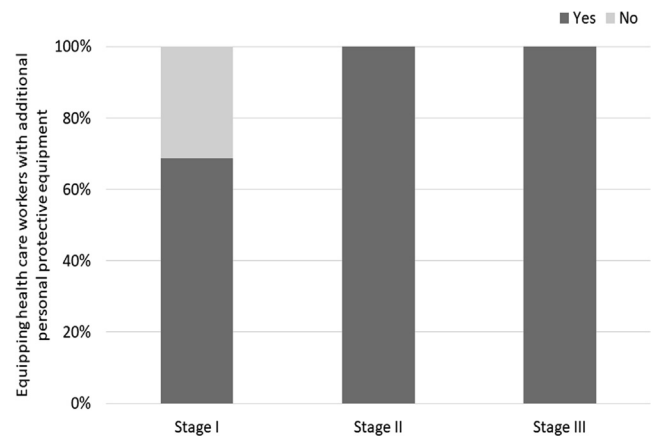


Fig. 10. Equipping health care workers with additional personal protective equipment during an epidemic (own elaboration).

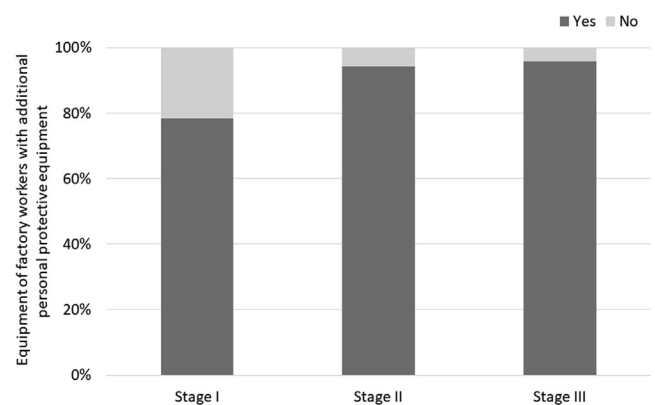


Fig. 11. Equipment of factory workers with additional personal protective equipment during an epidemic (own elaboration).

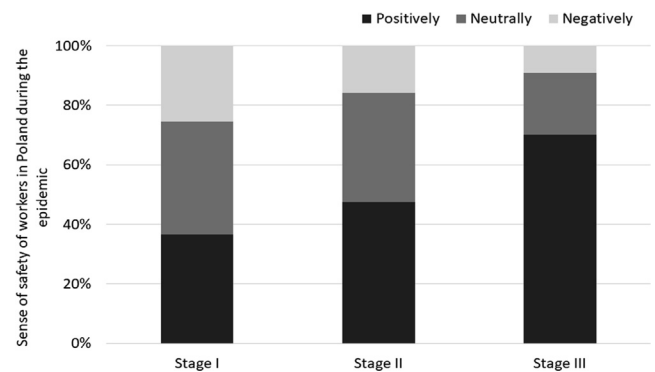


Fig. 12. Sense of safety of workers in Poland during the epidemic as assessed by the health and safety service (own elaboration).

This indicates insufficient preparation of the necessary procedures in health care facilities. This resulted in one of the higher percentages of detected infections among health care workers in Poland compared to other EU countries. In the case of industrial production, the observed phenomenon resulted from the desire and sometimes the necessity to maintain production capacity. In other sectors, despite the published guidelines, no significant increase in equipping employees with personal protective equipment was observed during the conducted research, which may be caused by a high percentage of employees equipped with PPE already in the first stage of research (about 80%) and the specificity of work which makes it difficult to use additional PPE. An example is the construction industry, where difficulties in the

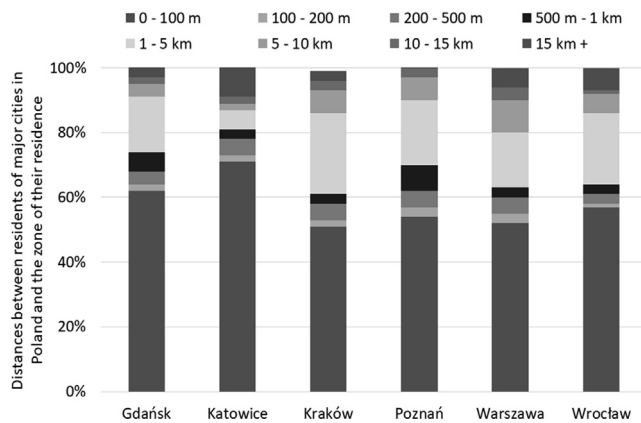


Fig. 13. Distances between residents of major cities in Poland and the zone of their residence (research conducted on 14–20 March 2020) ([www.selectivv.com](http://www.selectivv.com)).

selection of masks covering the nose and mouth of employees were pointed out due to their higher energy expenditure. Each of the masks tested limited air absorption; as is commonly known, increased energy expenditure increases the respirable parameters, e.g. minute lung ventilation.

The last issue analyzed in the framework of the conducted research was the feeling of safety of employees. The results of the research can be interpreted as feedback from the employees of the plants to the OSH service but also as a form of self-assessment of employees who believe that their employees are secured at an appropriate level. The results of the research indicate a growing assessment of the sense of security of employees at individual stages. The growing assessment, despite the extremely dynamic development of the epidemic and information flowing about thousands of deaths per day. The result of the Kruskal-Wallis test ( $p < 0.0001$ ) indicates that there is a statistically significant difference between the stages and the POST-HOC test particularly indicates differences in assessment between stages II and III. Taking into account that within two weeks between Stage II and III there were more than 1 million infected and about 100,000 fatalities worldwide, and in Poland about 5000 infected and more than 250 official fatalities, such a result of the tests proves the wide range of activities undertaken by companies to protect workers by COVID-19.

## 6. Conclusions

The epidemic is a particularly difficult time for employers. It is a time when the role of health and safety workers as an employer's advisory service is one of the key roles in maintaining production capacity. Research has shown that there are differences in the behaviour of OSH workers according to their length of service. It was found that in the analysed case the borderline length of service was 7 years. Employees with such seniority and more often worked methodically, and their actions were preceded by a documented analysis of the facts. Employees with less seniority did not document them when taking action, which may result in their misunderstanding by employees or employers.

The results of the research confirmed relatively positive actions of employers in the field of equipping employees with additional personal protective equipment in connection with the COVID-19 epidemic. Equipping employees with equipment increased in the course of the research from 76% to 93% in total, and in the case of health care from 70 to 100%. A negative conclusion from the research is low preparation of the health service for the epidemic, as 30% of health care institutions in Poland did not equip employees with additional protective measures at the beginning of the epidemic.

Health and safety workers in Poland, especially in the first two

stages of the study, assessed preventive measures related to the epidemic better in Poland than in the world. In the opinion of OSH workers, the feeling of safety of workers during the research increased as a function of time, which is a confirmation of positive assessment of actions taken by employers in terms of protection of workers against COVID-19 coronavirus.

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## References

- <https://www.pip.gov.pl/> (March. 20 – May. 13.2020).
- Zhang, Z., Liu, S., Xiang, M., et al., 2020. Protecting healthcare personnel from 2019-nCoV infection risks: lessons and suggestions. *Front. Med.* <https://doi.org/10.1007/s11684-020-0765-x>.
- Wright, A.L., Meyer, A.D., Reay, T., Staggs, J., 2020. Protecting healthcare personnel from 2019-nCoV infection risks: lessons and suggestions. *FRONTIERS OF MEDICINE*, DOI: 10.1007/s11684-020-0765-x.
- Al-Tawfiq, J.A., Rothwell, S., McGregor, H.A., Khouri, Z.A., 2018. A multi-faceted approach of a nursing led education in response to MERS-CoV infection. *J. Infect. Public Health* 11(2), 260–264. DOI: 10.1016/j.jiph.2017.08.006.
- MacIntyre, C.R., Seale, H., Dung, T.C., Hien, N.T., Nga, P.T., Chughtai, A.A., Rahman, B., Dwyer, D.E., Wang, Q.Y., 2015. A cluster randomised trial of cloth masks compared with medical masks in healthcare workers. *BMJ* 5(4), DOI: 10.1136/bmjopen-2014-006577.
- Wright, A.L., Meyer, A.D., Reay, T., Staggs, J., 2020. Maintaining Places of Social Inclusion: Ebola and the Emergency Department. *Admin. Sci. Quart.* DOI: 10.1177/0001839220916401.
- Fix, G.M., Reisinger, H.S., Etchin, A., McDannold, S., Eagan, A., Findley, K., Gifford, A.L., Gupta, K., McInnes, D.K., 2019. Health care workers' perceptions and reported use of respiratory protective equipment: A qualitative analysis. *Am. J. Infect. Control* 47(10), 1162–1166, DOI: 10.1016/j.ajic.2019.04.174.
- Oh, N., Hong, N., Ryu, D.H., Bae, S.G., Kam, S., Kim, K.Y., 2017. Exploring Nursing Intention, Stress, and Professionalism in Response to Infectious Disease Emergencies: The Experience of Local Public Hospital Nurses During the 2015 MERS Outbreak in South Korea. *ASIAN NURSING RESEARCH*, 11(3), 230–236, DOI: 10.1016/j.anr.2017.08.005.
- Khalid, I., Khalid, T.J., Qabajah, M.R., Barnard, A.G., Qushmaq, I.A., 2016. Healthcare workers emotions, perceived stressors and coping strategies during a MERS-CoV outbreak. *Clin. Med. Res.* 14(1), 7–14, DOI: 10.3121/cmr.2016.1303.
- Beardwood, B.A., Kainer, J.M., 2015. Exploring risk in professional nursing practice: an analysis of work refusal and professional risk. *Nursing Inquiry*, 22(1), 50–63 Special Issue: SI, DOI: 10.1111/nin.12048.
- Mitchell, R., Roth, V., Gravel, D., Astrakianakis, G., Bryce, E., Forgie, S., Johnston, L., Taylor, G., Vearcombe, M., 2013. Are health care workers protected? An observational study of selection and removal of personal protective equipment in Canadian acute care hospitals. *Am. J. Infect. Control* 41 (3), 240–244. <https://doi.org/10.1016/j.ajic.2012.04.332>.
- Mansour, A., 2018. Evaluation of health and safety management systems in the Sudanese industrial corporations: An external audit perspective. *Khartoum Univ. J. Manage. Stud.* 11 (1), 5–14.
- Chiroli, D., Baú, A., Deschamps, F., Sakakibara, E., Christóforo, L., 2019. Work safety management applied to a lab used by a junior company of chemical engineering. *Independent J. Manage. Prod.* <https://doi.org/10.14807/ijmp.v10i1.787>.
- Cronbach, L., 1951. Coefficient alpha and the internal structure of tests. *Psychometrika* 16 (3), 297–334.
- Nunnally, J., 1976. *Psychometric Theory*. McGraw-Hill Book Company, New York.
- Lilliefors, H., 1967. On the Kolmogorov-Smirnov test for normality with mean and variance unknown. *J. Am. Stat. Assoc.* 62, 399–402.
- Kruskal, W., 1952. A nonparametric test for the several sample problem. *Ann. Math. Statist.* 23, 525–540.
- Dunn, O., 1964. Multiple comparisons using rank sums. *Technometrics* 6, 241–252.
- Mann, H., Whitney, D., 1947. On a test of whether one of two random variables is stochastically larger than the other. *Ann. Math. Statist.* 1 8, 5 0 4.
- Plackett, R., 1983. Karl Pearson and the Chi-Squared Test. *Int. Statist. Rev.* <https://doi.org/10.2307/1402731>.
- DeLong, E., DeLong, D., Clarke-Pearson, D., 1988. Comparing the areas under two or more correlated receiver operating curves: A nonparametric approach. *Biometrics* 44, 837–845.
- Zweig, M., Campbell, G., 1993. Receiver-operating characteristic (ROC) plots: a fundamental evaluation tool in clinical medicine. *Clin. Chem.* 39, 561–577.
- Ling, M., How, K., 2012. Impact of a hospital-wide hand hygiene promotion strategy on healthcare-associated infections. *Antimicrobial Resistance Infection Control.* <https://doi.org/10.1186/2047-2994-1-13>.
- Yassi, A., Bryce, E., Breilh, J., Lavoie, M., Ndelu, L., Lockhart, K., Spiegel, J., 2011. Collaboration between infection control and occupational health in three continents: a success story with international impact. *BMC International Health Human Rights*.

- <https://doi.org/10.1186/1472-698x-11-s2-s8>.
- Gratton, J., Mclaws, M., 2011. Using evidence-based medicine to protect healthcare workers from pandemic influenza: Is it possible? *Crit. Care Med.* <https://doi.org/10.1097/ccm.0b013e3181fa3c28>.
- Tompkins, B., Kerchberger, J., 2010. Personal Protective Equipment for Care of Pandemic Influenza Patients: A Training Workshop for the Powered Air Purifying Respirator. *Anesthesia Analgesia.* <https://doi.org/10.1213/ANE.0b013e3181e780f8>.
- Martinese, F., Keijzers, G., Grant, S., Lind, J., 2009. How would Australian hospital staff react to an avian influenza admission, or an influenza pandemic? *Emergency Medicine Australasia.* <https://doi.org/10.1111/j.1742-6723.2008.01143.x>.
- Nichol, K., Bigelow, P., O'Brien-Pallas, L., McGeer, A., Manno, M., Holness, D.L., 2008. The individual, environmental, and organizational factors that influence nurses' use of facial protection to prevent occupational transmission of communicable respiratory illness in acute care hospitals. *Am. J. Infect. Control.* <https://doi.org/10.1016/j.ajic.2007.12.004>.
- Moore, D., Gamage, B., Bryce, E., Copes, R., Yassi, A., 2005. Protecting health care workers from SARS and other respiratory pathogens: Organizational and individual factors that affect adherence to infection control guidelines. *Am. J. Infect. Control.* <https://doi.org/10.1016/j.ajic.2004.11.003>.
- Esswein, E., Kiefer, M., Wallingford, K., Burr, G., Lee, L., Wang, J., Wang, S., Su, I., 2004. Environmental and Occupational Health Response to SARS, Taiwan, 2003. *Emerg. Infect. Dis.* <https://doi.org/10.3201/eid1007.030728>.
- DOI: 10.1089/sur.2020.097.
- Ordinance of the Council of Ministers of 2 September 1997 on the occupational health and safety service (Dz.U. 1997,109,704 ze zm.).